

Appl. No. : 10/810,415
Filed : March 25, 2004

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested. Figures 1C, 1D, 2C, 3A and 3B have been replaced with new Figures 1C, 1D, 2C, 3A and 3B, which have been amended to address objections to the drawings. The Specification has been amended to address an objection to the original title. Claims 14 has been amended to adjust its dependency and Claim 33 has been amended to clarify that the “repeating” step is optional. New Claim 63 has been added and is supported by original Claim 33. No new matter is added by these amendments. Claims 53-62 are herein canceled. Accordingly, Claims 1-52 and 63 are now pending.

Applicants submit that this application, as amended, is in condition for allowance and such action is earnestly requested. Each of the Examiner’s reasons for rejection is addressed below.

Objections to the drawings

The drawings were objected to for failing to comply with 37 CFR 1.84(p)(5). The Examiner found that the drawings “include the following character(s) not mentioned in the description: 116, 130, 140, and 326.”

Figures 1C and 1D have been amended to replace character “116” with character “114.” This amendment is fully supported by the application as originally filed at, for example, paragraph [0048] of the Specification.

Figures 3A and 3D have been amended to remove character “326.”

Figure 2C has been amended to replace character “240” with “235.” This amendment is fully supported by the application as originally filed at, for example, paragraph [0055] of the Specification.

Applicants respectfully disagree with the Examiner over the objection to characters “130” and “140” because they are mentioned in the Specification at, for example, paragraphs [0049] and [0056].

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Objection to the specification

The Examiner has objected to the title of the invention for not being descriptive. As suggested, Applicants have amended the Specification to replace the original title with the following new title: "METHOD FOR FABRICATING A SEED LAYER."

Claim objections

Claim 16 was objected to for including an incorrect claim dependency. Applicants believe that the dependency of Claim 16 is correct and respectfully traverse the objection. However, Claim 14 as originally filed erroneously depended from Claim 4. Applicants have amended Claim 14 to depend from Claim 13. This amendment is fully supported by the application as originally filed at, for example, paragraph [0054].

Section 112 rejection

Claims 33-52 are rejected under 35 U.S.C. §112. The Examiner has found that in Claim 33, the phrase "repeating the preparation process on the substrate n times, wherein $n = \{0, 1, 2, \dots\}$ " is indefinite because it is not clear how a repeating process can be performed when $n = 0$.

Claim 33 has been amended to clarify the invention. In particular, Claim 33 has been amended to clarify that "repeating the preparation process on the substrate n times, wherein $n = \{0, 1, 2, \dots\}$ " is optional. This amendment is supported by original Claim 33.

New Claim 63 has been added in view of the clarification of Claim 33. The new claim is fully supported by the application as originally filed at, for example, original Claim 33 and paragraph [0054] of the Specification.

Accordingly, applicants respectfully request that the §112 rejection of Claim 33 (and dependent claims 34-52) be removed.

Section 102 rejection

Claims 1-4, 10-13, 15-19, 21-24, 28, 33-37, 48, 49 and 52 stand rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,482,740 to Soininen et al. ("Soininen"). With respect to Claims 1, 19, 33, 48 and 49, the Examiner has found that "Soininen teaches depositing a diffusion barrier 14 on a substrate and oxidizing a top layer of the diffusion barrier 14 to form a

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metal oxide layer 16 (i.e., nucleation layer). A preparation process on the substrate is done to form a nucleation layer 16. The preparation process is done when $n = 1-10$. Reducing the oxidation state of the metal oxide layer 16 to form a first seed layer 16 and depositing a conductor 18 (i.e., Cu) directly on the first seed layer 16.” Office Action at Page 4.

With regards to Claim 1, Applicants respectfully disagree with the Examiner and submit that Soininen *deposits a metal oxide* layer on a diffusion barrier using alternate pulses of a metal source chemical and oxygen source chemical. See Soininen, col. 7, lines 26-29. In contrast, Applicants teach forming a metal oxide layer by “oxidizing a top layer of the diffusion barrier,” as recited in Claim 1. Even if the Examiner were to take the position that Soininen could first pulse an oxygen source chemical to oxidize a top portion of the diffusion barrier followed by pulsing the metal source chemical, Applicants submit that Soininen would still not teach the claimed method because Soininen reduces the metal oxide layer deposited *over* the diffusion barrier, not the metal oxide layer formed by oxidizing a top layer of the diffusion barrier, as recited in Claim 1. Further, Soininen neither teaches nor suggests reducing an oxidized portion of the diffusion barrier. Consequently, as Soininen neither teaches nor discloses the limitations of Claim 1, Applicants respectfully request that the §102 rejection of Claim 1 be withdrawn.

Claims 10-13, 15-19, 21-24 and 28 depend from and therefore include all of the limitations of Claim 1, in addition to reciting additional distinguishing features. Soininen neither teaches nor discloses the limitations of Claim 1, let alone the unique combination of features of Claims 10-13, 15-19, 21-24 and 28. Accordingly, Applicants respectfully request that the §102 rejection of Claims 10-13, 15-19, 21-24 and 28 also be withdrawn.

With regards to Claim 33, Applicants note that Soininen forms a seed layer by reducing at least a portion of a previously-deposited metal oxide layer (See Soininen, col. 7, lines 35-37), not by “*depositing* a conductor over the nucleation layer,” as recited in Claim 33. Consequently, as Soininen neither teaches nor discloses the limitations of Claim 33, Applicants respectfully request that the §102 rejection of Claim 33 be withdrawn.

Claims 34-37, 48, 49 and 52 depend from and therefore include all of the limitations of Claim 33, in addition to reciting additional distinguishing features. Soininen neither teaches nor discloses the features of Claim 33, let alone the unique combination of limitations of Claims 34-

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37, 48, 49 and 52. Accordingly, Applicants respectfully request that the §102 rejection of Claims 34-37, 48, 49 and 52 also be withdrawn.

Section 103 rejection

Claims 5-9, 14, 25, 26, 29-32, 44-47 and 50 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Soininen, as applied to Claims 1 and 33, and further in view of WO 01/29893 to Elers et al. ("Elers"). With respect to Claims 5-9 and 29, the Examiner found that Soininen discloses the claimed invention "except for the diffusion barrier comprising tungsten carbide or tungsten nitride carbide layer." Elers was found to disclose depositing a diffusion barrier comprising tungsten carbide or tungsten nitride carbide by ALD. The Examiner asserts that "one skilled in the art at the time of the invention would readily recognize substitute the carbide layer for the nitride layer of Soininen, since the carbide layer would facilitate high quality ultra thin layer while providing a corrosion protection for the substrate as taught by Elers." Office Action at Page 7. The Examiner poses this as substitution of a carbide film for a nitride film. However, Applicants note that the claim is directed to a three-component (or ternary) diffusion barrier, not a two-component (or binary) diffusion barrier.

Without acquiescing in the Examiner's reasons for rejection, Applicants contend that Claims 5-9, 14, 25, 26, 44-47 and 50 are allowable because they depend from and therefore include all of the features of Claims 1 and 33, in addition to reciting additional distinguishing features. Elers does not make up for the deficiencies of Soininen with respect to Claims 1 and 33. In view of the asserted allowability of Claims 1 and 33 (see above), Applicants respectfully request that the §103 rejection of Claims 5-9, 14, 25, 26, 44-47 and 50 be withdrawn.

Applicants respectfully disagree with the Examiner over the rejection of Claim 29. Elers does not teach or disclose a method for "forming a **tungsten nitride carbide** diffusion barrier on a substrate," as recited in Claim 29. Elers is concerned with forming binary compounds, such as metal nitride or metal carbide compounds, not ternary compounds. See Page 5 and Figure 8 of Elers. Although Elers suggests that his methods can be applied to depositing ternary materials (see Elers, page 13), Elers does not provide a recipe for doing so. In addition, there is no suggestion in Elers (or Soininen) that would motivate one of skill in the art to substitute a ternary compound for the binary compound of Soininen. Further, neither Elers nor Soininen teaches or

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suggests any particular advantage to be gained from making the asserted substitution. Consequently, the asserted combination does not meet the limitations of Claim 29, and Applicants respectfully request that the §103 rejection of Claim 29 be withdrawn.

Claims 30-32 depend from and therefore include all of the features of Claim 29, in addition to reciting additional distinguishing features. As the Examiner has not made a prima facie rejection of Claim 29 Applicants respectfully request that the §103 rejection of Claims 30-32 also be withdrawn.

CONCLUSION

In view of the foregoing amendments and remarks, Applicants respectfully submit that this application is in condition for allowance. If there is any further hindrance to allowance of the pending claims, the Examiner is invited to contact the undersigned.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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AMENDMENTS TO THE DRAWINGS

Please replace Figures 1C, 1D, 2C, 3A and 3B with new Figures 1C, 1D, 2C, 3A and 3B. Replacement drawing sheets for Figures 1C, 1D, 2C, 3A and 3B are enclosed with this Amendment.